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(54) **APPARATUS COMPRISING A QUANTUM CASCADE LASER HAVING IMPROVED DISTRIBUTED FEEDBACK FOR SINGLE-MODE OPERATION**

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(52) **U.S. Cl.** **372/96; 372/92; 372/45**

(58) **Field of Search** **372/96, 92, 45**

(56) **References Cited**

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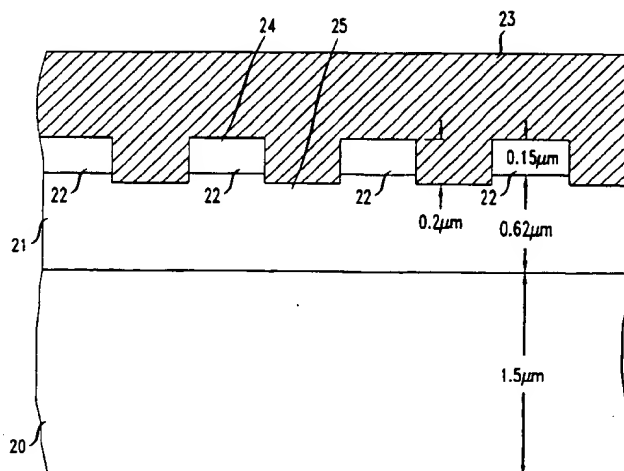
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(57) **ABSTRACT**

An article comprising a QC-DFB laser is disclosed. In the QC-DFB laser, an overlying grating structure achieves relatively strong coupling of the guided mode to the grating, and is thus highly effective in inducing single-mode operation even under cw operating conditions. The grating structure includes grooves etched in a plasmon-enhanced confinement layer (PECL) disposed adjacent and in contact with an upper metallic electrode. The grating structure and the PECL are designed such that in the grooves, the laser mode travelling in the waveguide can couple efficiently to the surface-plasmon at the electrode interface. This results in strong modulation of the laser mode, leading to strong modulation of, inter alia, the effective refractive index.

16 Claims, 4 Drawing Sheets



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TITLE: Apparatus comprising a quantum cascade
laser having improved distributed feedback for
single-mode operation

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Detailed Description Text - DETX (30):

In general, QC-DFB lasers can advantageously be used in point sensing apparatus and in remote sensing apparatus for spectral analysis and detection of many substances, particularly gaseous substances, having infrared spectral features. Numerous well-known instrumental configurations incorporating a QC-DFB laser are useful in this regard. Without limitation, such configurations include wavelength modulation, direct absorption, photoacoustic cell (PAC), and cavity ring down (CRD) configurations. Published descriptions of spectroscopic instruments incorporating QC-DFB lasers include: R. M. Williams et al., "Kilohertz linewidth from frequency-stabilized mid-infrared quantum cascade lasers," Optics Letters 24 (1999) 1844-1846; B. A. Paldus et al., "Photoacoustic spectroscopy using quantum-cascade lasers," Optics Letters 24 (1999) 178-180; A. A. Kosterev et al., "Methane concentration and isotopic composition measurements with a mid-infrared quantum-cascade laser," Optics Letters 24 (1999) 1762-1764; and K. Namjou et al., "Sensitive absorption spectroscopy with a room-temperature distributed-feedback quantum-cascade laser," Optics Letters 23 (1998) 219-221.

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